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SPACECAST 2020 was a Chief of Staff of the Air Force(CSAF)-directed space study, challenged to identify and conceptually develop high-leverage space technologies and systems that will best support the warfighter in the twenty-first century. This is the third of four monographs: Executive Summary, The SPACECAST 2020 Process, The World of 2020 and Alternative Futures, and Operational Analysis. SPACECAST 2020 teams used different proposed futures to enrich concepts about future space activity. The study group developed a most likely future, the SPACECAST world view, and several alternate futures. This monograph details the distant future as constructed by military officers as a backdrop for their exploration of ideas about the United States space activity circa 2020.

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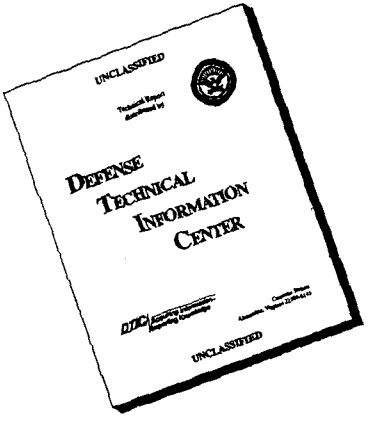

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The World of 2020 and Alternative Futures

If a man does not give thought to problems which are still distant, he will be worried by them when they come nearer.

—Confucius
The Sayings of Confucius

Defining the distant future is a hazardous enterprise. One is invariably wrong on many counts. Failing to consider the future is even more hazardous. It leads you to engage in the wrong enterprise with invalid or irrelevant objectives, only to fail to achieve your desired results while continually being buffeted by unanticipated events and unintended consequences. What follows is a look into the distant future constructed by military officers as a backdrop for their exploration of ideas about the United States space activity circa 2020.

SPACECAST 2020 is the name of the study. One hundred fourteen officers and civilians attending the Air Command and Staff College and the Air War College at Maxwell Air Force Base, Alabama, during the 1993–1994 academic year conducted the study. Gen Merrill A. McPeak, the chief of staff of the Air Force, requested the study. The study chair was the commander of Air University, Lt Gen Jay W. Kelley. Under General Kelley's supervision, Air University personnel devised the process to produce new ideas and executed the study to produce and validate those ideas.[1] All this had to be accomplished within the confines of the Air University academic year and be completed by June 1994. The guidance required that the study: (1) be characterized by unconstrained creativity, (2) remain detached from redefining service organizational structures or redefining the assigned roles and missions of the armed forces, (3) be centered on generating a vision of the military space capabilities our country would require in the far future, and (4) not interfere with the core curricula of any of the Air

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University colleges. Although not part of the study's original mandate, General Kelley created two oversight groups apart from the Air University to advise the study participants and evaluate their progress and findings. General Kelley defined a key requirement of his role as study chair as being the only person involved in the study with the power to say no.

As the study group began exploring new ideas and learning about creativity, space, and the future, they quickly concluded that a clear consensus about the future environment was critical to the realistic evaluation of new concepts and technologies. Assumptions about the SPACECAST 2020 world needed to be explicit for effective planning. As the study group set about forging a consensus about the future, some participants raised concerns about the potential for stifling creativity and increasing the risk of being wrong by planning around a single view of the future. To reduce the risks of either being fuzzy or being wrong, the study group developed multiple visions and sets of crystallized assumptions. The study group developed a most likely future, the SPACECAST world view, and several alternate futures.

Creating Views of the Future

The SPACECAST 2020 method of creating a realistic set of planning horizons blended expert opinion with unbiased, critical analysis and synthesis. While a few of the participants had graduate education in strategic planning and corporate-level experience, most were bright operators—technical experts in the application of military power. These operators needed to be educated about the future. SPACECAST 2020 exposed the participants to futurists, scientists, science fiction writers, Hollywood screen writers, as well as political, economic, social, and technology experts. Since the visions, projections, and data from these experts often conflicted, the participants were empowered to extract the most persuasive insights.

To synthesize the complex and discordant perspectives on 2020 and beyond, participant groups constructed independent glimpses of the world of 2020 from which common

salient features were extracted. Fourteen groups sifted through the data and developed brief presentations depicting their ideas about the operating environment of 2020. A senior group of participants evaluated the substantive merits of each projection and elicited the common, highly likely assumptions. The group then forged a consensus world view, which was presented to all participants and iterated several times. The SPACECAST 2020 world view captured the most likely environment for US activity related to space in the future and became the planning basis for the study's concept and technology generation and assessment.

While the SPACECAST 2020 world view captured the dominant features of the expected future, the SPACECAST 2020 assumptions omitted some highly stressful potential events and circumstances. The participants referred to some of these variant disasters and contrasting frames of reference as the rogue set. Most agreed that the events in the rogue set were too improbable to form the basis for the study or US policy, yet they were too interesting to ignore. Fascination with the rogue set and some of its potential consequences sparked recognition that unusual, high impact events could be so disruptive that they warranted further consideration. The participants decided that alternate future worlds were needed to bound the risk associated with concentrating on a single or unitary view of the more likely future events. Alternate future scenarios also held promise as a tool for judging the robustness of new concepts and technologies generated in the study.

Developing Alternate Future Worlds

To supplement the SPACECAST 2020 assumptions about the future, eight participants and two consultants from The Futures Group developed a series of alternative futures.[2] Alternate futures, alternate worlds, or scenarios are terms used interchangeably in strategic planning in this study. Scenarios, intended for use as background for planning and assessing alternate strategic courses of action, are descriptions of future conditions. To be effective, scenarios or alternate futures must have several key ingredients (fig. 1).

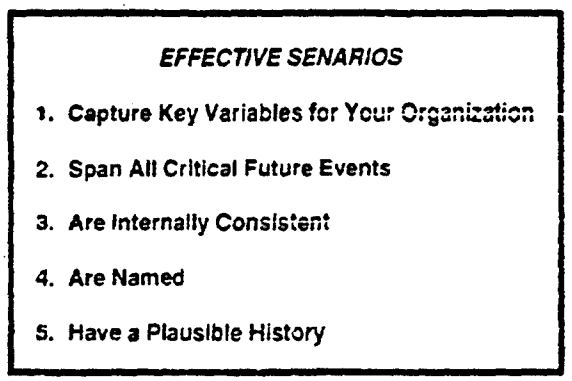

Figure 1. Scenario Characteristics

First, scenarios must capture the key variables which shape the environment of the organization engaged in strategic planning. For example, a study on scenario use noted that the key planning drivers for US trucking companies were the price of oil products and the amount of federal and state regulation.[3] In comparison, no other characteristics of the marketplace mattered.

Second, scenarios must describe a wide enough range of future situations so that unlikely, but high payoff or disastrous events would be considered in planning. For example, even though no one predicted the toppling of the Berlin Wall, the collapse of the Warsaw Pact, or the dissolution of the Soviet Union, an Air Force study constructed four alternate futures, one of which considered a world where the Soviet Union was no longer a significant player.[4]

Third, scenarios must be internally consistent. For example, a situation of dramatic economic growth and wealth distribution spurring technological progress could not exist in the same scenario as a catastrophic collapse of the financial markets. Each would be interesting and stressful planning situations, but it would be inconsistent to consider both situations in the same scenario. The collapse of the markets would certainly preclude economic and technological growth. Planners would have to consider such situations in separate scenarios.

Two additional techniques of scenario building significantly increase the value of alternate futures for planning. To make scenarios come alive, they must have a history and a name. The scenarios themselves describe the future environment, but this environment needs a plausible evolution of events and trends leading from the present. Experience repeatedly demonstrates that once a scenario has a name epitomizing its character, corporate or organizational planners and study participants quickly internalize the scenario and begin to flesh out and describe its details. Thus, alternate futures or scenarios are not forecasts of what will be, they are ways to capture the breadth or range of future challenges and opportunities confronting leaders and planners.[5]

Constructing Alternate Futures

To begin constructing the alternate futures, the SPACECAST 2020 team asked what drivers would shape a future environment that would be of strategic planning interest to the United States' space-related activity. Using classic creative thinking techniques such as brainstorming, the group considered over 60 potential drivers. Potential drivers suggested for consideration included: the number and nature of powerful political and economic actors; organizing principles of actors; centralized or decentralized power distribution; interest groups and constituents; incentives and disincentives for involvement in space; public infatuation with space; population growth in developing countries; political and social will as it relates to space; global economic capability; world economic conditions; the relative economic strength of the United States; US competitive capability; the size of the US defense budget; the degree of global economic integration; the availability of energy and natural resources; the degree of regionalism; the degrees of cultural commonality and continuity that could be envisioned in the world; political instability in the third world; the nature and extent of military alliances; terrorist disruption and disruptive potential; technology diffusion and proliferation; the future vulnerability of data, hardware, and transmission; the degree of conflict; biogenetic threats or havens; the locale in which military activities will take place; and the type of available weaponry.

Next, the SPACECAST 2020 team grouped these drivers using affinity diagrams to decide what three or four variables would capture the relevant planning environment. The team recognized that many of the drivers were closely related and linked directly and indirectly. Although the team discussed and considered the causal links between the variables which would shape future worlds, the methodology of using alternative futures for planning does not require the explication of these links. Instead, broad descriptors are needed which implicitly encompass the specific drivers and which can paint the future landscape with broad strokes. The team referred to these broad descriptors as dimensions of the future world. As the team grouped the drivers, three dominant dimensions emerged: the number of actors playing a role in space; the will of the actors to use space; and the technological proliferation and growth and economic vitality of the actors, or their technomic capability.[6] The interaction of these dimensions promised to be interesting. For instance, the team envisioned that if there were many actors involved in space and the technomic capability to operate in space expanded geometrically, the future would be highly competitive. Similarly, if economic growth and technological progress had not advanced markedly from today but a few actors had a very strong desire to be involved in space, the future might be quite conflictual.

Once the key dimensions came into focus, the team varied these dimensions to yield eight alternate futures (fig. 2). The number of actors varied from few to many. The technomic

No. Actors with Space Role	Technomic Vitality	Will to Use Space	
1. Many	High	Strong	(SPACEFARING)
2. Many	High	Weak	(TERRESTRIAL FOCUS)
3. Many	Low	Strong	(MAD MAX, INC.)
4. Many	Low	Weak	(BALKANIZED)
5. Few	High	Strong	(SPACE BARONS)
6. Few	High	Weak	(SPACECAST)
7. Few	Low	Strong	(ROGUES)
8. Few	Low	Weak	(FUNDAMENTALIST)

Figure 2. Alternate Worlds of 2020

vitality spanned from low to high. The desire of the actors to be active in space stretched from weak to strong.

Naming the eight alternate worlds breathed life into each. For instance, the participants considered a world in which many actors had a strong desire to be in space but the capability reflected in technomic progress and vitality was severely constrained. Team members evaluated whether such a world would spawn cooperation to use limited resources to gain space access for the many. Such cooperation might be coordinated through governmental and nongovernmental international organizations. Such a world might be dubbed a UN world. On the other hand, the world might be more conflictual as many actors competed to obtain scarce resources to fuel their thirst for space. Further, the actors might not be governments. Team members became intrigued by visions of a competitive, conflictual world in which corporations sought

Steps in Preparing a Set of Alternate Futures

1. ***Select Important Characteristics or Drivers:*** The Issues and Conditions Most Important to Shaping the System or Environment Being Studied
2. ***Aggregate Drivers into the Few Key Dimensions*** that Will Be Used to Delineate the Future Operating Environment
3. ***Set Range of Values*** for the Dimensions that Will Be Studied
4. ***Select Number of Scenarios that Will Be Studies:*** Combinations of the Dimensions that Are Internally Consistent, Sufficiently Plausible and Capture the Range of Threats and Opportunities
5. ***Designate Indicators and Trends*** that Will Be Treated in Each Scenario
6. ***List Important Events:*** Developments that are Necessary for the Conditions of Each Scenario and Those Important to Shaping the Indicators and Trends
7. ***Prepare Narratives:*** Describe Evolution of Conditions in Each Scenario Spotlighting Key Events/Developments, Important Trends, Imiplications for the System or Environment Studied

Source: This methodology is used by several groups associated with strategic planning. It was used during the *Air Force Innovation Study* and during SPACECAST 2020. This particular sequence is drawn from The Futures Group.

Figure 3. Alternate Futures Methodology

competitive advantage through access to space. They dubbed this world Mad Max, Inc. Once named and characterized, participants quickly began imagining and providing details about the world. This process continued for each of the eight potential alternate futures.

Finally, the team chose three of the eight for further development to supplement the most likely SPACECAST 2020 future. A Spacefaring world, a Rogue world, and a Mad Max, Inc. world would be significant contrasts to the SPACECAST 2020 future and be tough tests for the studys developing concepts and technologies. The team was also interested in the implications of a world dominated by Space Barons. It appeared remarkably similar to the SPACECAST 2020 world with the addition of space entrepreneurs. Such a future was familiar enough and such a plausible extension of today and SPACECAST 2020 projections that the team chose to explore a Space Barons world along with the SPACECAST 2020 future.

Figure 4 displays the strategic planning space in which the study group expected the United States to operate in the future. When the alternative futures were depicted on

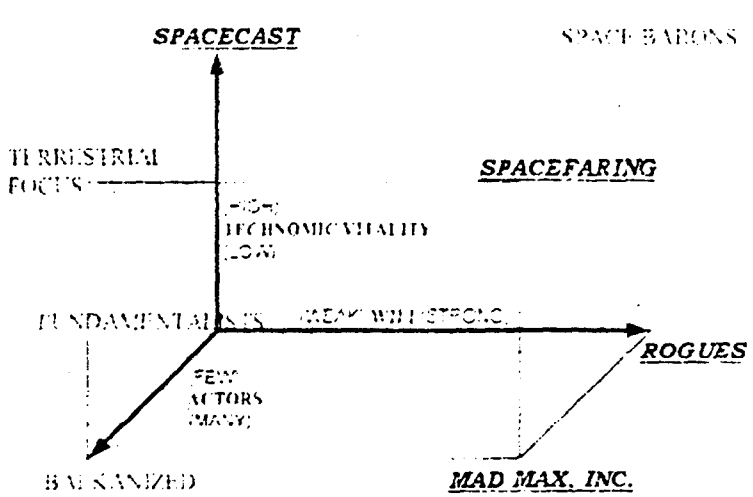

Figure 4. SPACECAST 2020 Scenario Planning Space

the axes of actors, will, and technomic vitality, the team noted that the worlds chosen for detailed exploration appeared skewed on one side of the space. On reflection, while considering Balkanized, Fundamentalist, or Territorially focused futures would be useful for some planning problems, they were less relevant to the SPACECAST 2020 charter. The worlds chosen held the most promise for meaningful insights into space-related activity.

Alternate Futures

What follows are descriptions of each of the future worlds used in SPACECAST 2020. The pattern is to note the character of the three dimensions, highlight the historical events that might have led to such a world in about 2020 or beyond, and to describe the world.

Spacefaring World

The Spacefaring world is characterized by many actors with a strong desire to be involved in space. This world also has high technomic vitality representing the capability to be involved in space.

The historical events that preceded the Spacefaring world were marvelous times in which to live. Prior to 2020, there were geometric advances in communication and information interconnectivity which were shared with the inhabitants of each continent. Much of the sharing was made possible by the success of the Global Agreement on Trade and Tariffs (GATT) which led many to increasingly refer to the entire planet as a highly interdependent global village. The few remaining rogue states that may have inhibited development and spread of space and technological activity will have been swept away by dual waves of glasnost and economic activities. The competitive atmosphere among states and transnationals had been intense and fueled the early development of advanced space-launched methods. Cheap, reliable spacelift had spawned from a variety of sources and was not limited to states and corporate barons. This fierce competition extended into the economic realm and into space, but it had developed in a fairly friendly and

nonconflictual manner. The interweaving of competition and cooperation produced a dynamic synergism boosting space activity. The entertainment industries and education facilities responded to these developments by increasingly using space as a setting for both entertainment and education, continually sparking the imaginations of populations worldwide. As these events unfolded, the military increasingly assumed the role of policeman and space-traffic controller.

A Progressive Spacefaring Future. The Spacefaring world is characterized by many actors with strong desires to engage in space-related activity enabled by vast economic growth and proliferation and ebullient technological vitality. Specifically, the government is one of many actors in the Spacefaring world where individuals, transnationals, and supranationals are all highly active and competitive within a stable interdependent environment. Free trade and a global industrial policy stimulate technomic vigor. Space investment is an economic reality with wide economic opportunity available to many. Technology proliferation is global in the Spacefaring world, with space surveillance, communication, and cellular information nets commonplace. Energy is cheap and prolific, and readily available advanced propulsion systems are enabling resources for space travel. The expectation of inevitable progress and expanding space activity is pervasive.

Technically challenging higher education is global. Cheap information technology facilitates the development of high payoff education techniques as well as the dispersal of new, exciting ideas. High imagination stimulated by education is another feature of the Spacefaring world. Space visionaries and entertainers and space tourism are standard features of this world. One often hears people discussing endeavors in space for the entertainment value.

Political leadership encourages growth in space activity as a natural venue for expanding human endeavors. Political leaders are buttressed by the perception of a stable environment as evidenced by an adherence to space law and strong space constituent groups to encourage continued activity. Political leaders have also spearheaded sophisticated social service and social support services to

supplement the demassified, individualized, and decentralized structures of the Spacefaring world.

The Space Traffic Controller Features. A Spacefaring world has unusual implications for the nature of space activity and the nature of the military role in space. In this world, space activity is proliferated, global, and expanding and the military is involved across the board, even though the militarization of space is limited. Counterforce activity is rated low when compared to other worlds.[7] Many military activities are related to deconfliction and potential planetary defense. The amount of logistics activities carried out by the military is low, in large part because these functions are performed by other enterprises.[8] Military space-based monitoring and reporting is moderate compared to other potential futures, but much of this activity is dual-use and is expanding in both military and civilian sectors.[9]

The civilian and government role in space is very high as is the level of commercial involvement. Many facets of government enterprise in space could be characterized as space traffic control. The deconfliction of disperse space endeavors has become a routine but extremely complicated process. A great deal of military resources are dedicated to supporting the space control systems. A key driver for this network is the fact that commercial lift is abundant and available and the cost-per-pound for lift is cheap. Cheap lift and reliable infrastructure bolsters the increasingly common occurrence of humans in space. In fact, there are discussions and initial activity about hotels in space to augment the existing space stations.

While the Spacefaring world has interesting implications for the United States and the US military in space in the world of 2020 and provides a useful background for planning purposes, other alternate futures would present highly different and unique challenges.

Rogue World

The second alternate future developed was called the Rogue world. This is a world in which there are few actors with a desire to be in space and limited technological and

economic capability, but the will of some actors to be involved in space will be very high.

The history leading up to this world focused on the danger of a rogue state unchecked. A number of years before 2020, the failure of GATT spawned an era of neoprotectionism and a world economic downturn. Advances in communications and information interconnectivity failed to overcome deep-seated prejudice and traditional cultural barriers. Several fundamentalist and extremist states become closed, highly controlled societies in a quest for cultural purity. More than one rogue state developed reliable indigenous spacelift, a demonstrated antisatellite capability, and a willingness to violate space law. This perceived threat brought renewed US emphasis on space defense and an increased military role in space.

A Future Threatened by a Rogue Menace. The features of this world are characterized by a few space actors, low technomic vitality, and a strong will for involvement by some. The interesting actors are principally states and political actors. For example, some actors might be a totalitarian or a highly ideological state or states, and these rogues will be seeking influence. There will be few space entrepreneurs in this world, and the international political system will be characterized by shifting alliances. The low technomic vitality will be evidenced by tiered shifting economies, protectionism, and embargoes against the rogues. These rogues will be willing to sacrifice domestic needs to preserve national security and to receive the prestige associated with space activity.

The technologies associated with the Rogue world are predictable advances from 1994. Few breakthroughs are evident. Rogue states are forced to rely on essentially indigenous technology. As a result of the lack of cooperation associated with the spread of scientific knowledge, this world has limited or little advanced propulsion. The existing propulsion and lift are mainly allocated to and operated by the military.

Information in this world is expensive and dispersed; fear seems to permeate because of a distrust of information. In many domains, fiber optics are controlled by the state as

it attempts to control information to its population. People in the rogue states are educated in an irregular fashion; other states tend to be somewhat better. The rogue state seems to be motivated by a threat from some ideological or religious adversaries; other states are less consumed by ideological threats, but are inclined to take action to oppose the rogues if they share some of the same motivations. Some of the rogue adversaries are believed to have weapons of mass destruction in space. The perceived high value associated with space resources has tended to provide strong incentives to protect space assets against perceived threats.

Political leadership has been key both in causing the rogue state to take its position as well as to produce a response from the United States and its allies. Limited technomic capability has restrained many potential space opportunities. Limited opportunity has been offset by passionate political pressure in the United States and elsewhere to protect American assets and livelihood against rogue threats.

Space: Shield or Battlefield? The use of space in the Rogue world is limited, but leaders of such a state perceive it to be critical. The military's role in space is on the rise. Counterforce potential is very high and increasing, particularly with the development of highly capable antisatellite weapons (ASAT). The military's logistical role in space is moderate and characterized by limited activity and infrastructure. On the other hand, the military's role in monitoring and reporting is high. The relationship between civilian and government space activity is weak and the amount of activity has been essentially low. The weakness of commercial activity is related to the high cost of lift. The cost-per-pound of lift is slightly more expensive than in the 1990s. Thus, spacelift tends to be government-dominated. There is almost no human activity in space.

Mad Max Incorporated World

The Mad Max Incorporated world is characterized by many actors with a strong desire to be in space, but actors who are limited by very low technomic vitality. The dominant

space actors are corporate rather than political entities. This world is very competitive and potentially conflictual.

The history leading to the Mad Max Incorporated world is bleak. One catastrophe followed another. Most dramatic was a small nuclear exchange which did not involve the United States, but which resulted in an environmental nightmare occurring in South Asia. Shortly thereafter, a devastating earthquake in California decimated the US economy and led to mass internal migrations. Postindustrial states increasingly responded to these and similar crises with a complete redirection toward social programs, environmental cleanup, and disaster relief. The result of individual and multistate reaction was the creation of a complex internal and international regulatory environment. The domestic regulatory environment was stifling; the external attempts at regulation were misdirected and permeable. Multinational corporations, which were quicker to recover than states, filled the void created by nation states who diverted resources to internal social support. These corporations took over many former public sector tasks. Corporate and individual economic concerns led to decreased clout for states and a further rise of multinational corporations. Many military forces, including space assets, were increasingly made available to the highest bidder to sustain corporate activities.

Space as a Corporate Niche. Space actors in the Mad Max Incorporated world are predominantly corporations. Governments in this world have become welfare states or welfare guardians. The highly regulatory environment with complex political and legal interconnectivity tends to compel corporations to transcend the geographical constraints of government. The low technomic vitality is characterized by the continuous shifting of internal corporate resource allocations as companies move money from state to state to meet their needs. Trade is moderate, and corporations are pursuing profits while states are focused on domestic needs.

Technology development and its proliferation are irregular. There is limited advanced propulsion, but some corporate lift. Information gathering is irregular. States provide basic information, but sophisticated information

nets abound. Information security is a prime value for corporate economic purposes. The state provides education in its basic form, but corporate education and training, or feudal universities, are developing in the Mad Max world. The corporate actors' search for havens from national regulatory environments have led some to search for escapes in space. Resource and energy opportunities in space are further factors driving some corporations toward space.

Wide-scale political and social space vision has been lost. Political leaders have abandoned space to corporations seeking a niche in space. Political leaders explain away this lack of policy by claiming that the cost of space is too high and the taxpayers are not willing to foot the bill. Instead, political leadership is increasingly consumed by reactions to crises relating to welfare, health, and protection of the environment.

In Space: Businessmen and an Occasional Mercenary. The nature of space in the Mad Max world takes a commercial focus with military activity decreasing. Counterforce activity is very low and, to the extent that it exists, is chiefly corporate. Military logistics are commercially driven. Monitoring and reporting activity is moderate with dual uses, between government and military on the one hand and corporate business on the other. The chief determinant of a military role in space relates to preserving proprietary corporate secrets and net advantage rather than protecting hardware. Often space-based information security is managed by corporate hired security forces. Civilian government roles are low to moderate. There is low civilian government activity versus high commercial activity. The cost-per-pound for lift is lower than it was in the 1990s and is essentially commercial. The potential for humans in space is moderate in the Mad Max world.

SPACECAST 2020 and Space Barons World

By way of comparison to the three preceding alternate futures, this section summarizes the SPACECAST 2020 most likely future in the same format. In addition, this section also describes a variant of the SPACECAST 2020 future in which corporate entrepreneurs, Space Barons, play a role. This paper

develops the dimensions of the SPACECAST 2020 expectations in greater detail in a following section.

The key dimensions of the consensus future of SPACECAST 2020 are generally shared by the Space Barons world. That is, SPACECAST anticipates remarkable advances in technology supported by widespread but unevenly distributed economic vitality. Despite the considerable capability this growth represents, few Americans or others have a strong desire to operate in space. A variation of the SPACECAST 2020 projections anticipates that several Space Barons have decided to fill the gap left by government. Thus, Space Barons are individual entrepreneurs involved in space.

Prior to 2020, political, economic, and social activity relevant to space was inconsistent and lacked focus. Only the Space Barons seemed to have a sense of mission. Part of the confusion resulted from a single nuclear incident which occurred prior to 2020. Fortunately the event did not precipitate World War III On the other hand, states continually shifted from military to economic competition creating confusion about what constituted a military threat, and what was merely economic leverage. Increasingly, wealthy northern countries formed several pragmatic alliances and consortia widening the gulf between "have" and "have-nots." High-tech alternate terrestrial options such as fiber optics slowed the drive to develop advanced space systems. The lack of political will to be in space opened the window to Space Barons such as Motorola, Microsoft, and CNN (Cable News Network).

Key Dimensions. The SPACECAST and Space Barons world are represented by few actors, high technomic vitality, and moderate to low will to get involved in space. The consequential players continue to be nation states with the addition of some corporate space barons. The United States has tended to dominate such a world, but by no means has a monopoly on any feature. Instead, technomic vitality is derived from regional and transnational economic blocks. With the high stress on transnational wealth production and management, space money tends to be subject to budget cuts, and military/civilian dual-use activities and projects are important for conserving limited financial resources.

Technology, information, and education continue to promise much, yet fall short of the expectations of some. Technologies are moderately proliferated, and some advanced propulsion technology exists. Information could best be characterized by increasing local area networks rather than a complete global internet. Education increasingly integrates computers to assist in tasks, but virtual reality and other nontraditional educational methods are only used in selected subjects.

Political leaders continue to articulate interest in space activity, but seem constrained by competing constituent groups and mollified by the initiative of enterprising space barons. Political leadership tends to be divided between an earth and a space focus. Political will could be measured by the limited nature of space involvement which tends to be characterized by few states concerned about security threats, and a few space barons seeking economic niches and profits. Popular imagination has not reacted to limited space activity in part because popular media such as movies and video games seldom evoke space images or encourage space exploration. The diffuse democratic and multipolar social structures further mitigate a minimalist space focus.

Space: An Unexploited Vantage. Military activity will support space logistics, counterforce, and monitoring and reporting from space, but all will be limited. Counterforce activity will be limited. Logistics activity will be very limited, except for the space barons. Monitoring and reporting will be chiefly a military task. The level of civil government activity will be low. The level of commercial activity will be moderate. In terms of lift, the cost-per-pound will be slightly cheaper than today but no breakthrough in lift technology will be envisioned producing a need for cooperation between civil and military sectors. The potential for humans in space, envisioned in this most likely future, is low.

The SPACECAST 2020 world and the Space Barons world have a few important differences. Each world leads to different space architectures. When Space Barons dominate space development, research and development tend to produce systems designed without concern about hostile conditions and high vulnerability to attack. In addition, reduced abilities to collect against noncooperative targets

can potentially degrade US intelligence and communications. The principle difference between the most likely SPACECAST 2020 future and a world dominated by Space Barons relates to the question of who owns the space architecture.

The Future in 2020 and Beyond

SPACECAST 2020 Assumptions and Implications

Many details about the future can be extrapolated from what we know today. Demographic trends, for example, are highly predictable. Defining the future with as much richness and rigor as possible aids in providing a structure for thinking about upcoming trends and events, identifies the interconnectivity of many variables shaping one's environment, and highlights the implications of current policy and practice.[10] A richly defined future also stimulates creative thought, concepts and requirements generation, and technological opportunities and challenges. For these reasons, the SPACECAST 2020 study group described their consensus view of the future in 2020 and the following decades in greater detail than the alternate worlds discussed above.[11]

What follows are the SPACECAST 2020 assumptions about the most likely environment the United States will face in the future and significant implications of that future. This describes the five forcing functions molding the future world system, sources of future world conflict, and emphasizes the postulated future interdependency between the military and the civil-commercial sectors.

The specific objective of studying the potential scope and direction of the changes to occur on the planet in the next three decades was to try to understand the key features of the operating environment of the far future. Much of the description of the SPACECAST 2020 assumptions project changes and trends active today rather than describing an alternative future. In this way, the SPACECAST 2020 assumptions link the present with the future. By using the combination of looking from the present to the future and from the future back to the present, SPACECAST 2020

combined the merits of different strategic planning methodologies to maximize insight.

Five Forcing Functions Molding the Future World

Participants believe there are five forcing functions affecting the world system: the number and distribution of people on the planet, the world's geopolitical organizations and interactions, the world's economic processes, the effects of new technologies, and the constraints imposed by the natural environment (fig. 5). Each of these functions will affect US space capabilities.

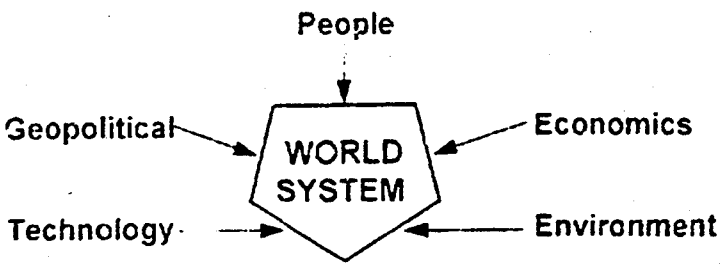

Figure 5. Forcing Functions

These forces are difficult to balance or keep in harmony and are further complicated by independent decisions of world leaders. In dealing with each other, the SPACECAST study participants concluded human beings have four options: they can cooperate and make the world better together; they can compete with each other, which may or may not make the world better; they can confront each other and negotiate changes to the world system; or they can fight, resulting in conflicts that might hurt or destroy the world system. Whatever the world community decides to do, the ultimate outcome depends on the character of the actors and their modes of interaction.

People. Based on available models, the earth's population is projected to grow from five billion today to over eight billion by 2020. It will probably double to 10 billion by the

year 2035, unless some type of catastrophe stops the trend. The greatest growth is expected to occur in the poorest regions, primarily in equatorial and Southern Hemisphere countries. Many of the postindustrial states, most of which are in the Northern Hemisphere, will see a graying of society. This graying will occur due to longer life expectancies in the North made possible by medical and biomedical technology and healthier lifestyles. In contrast, less industrially developed, poorer states (especially in the equatorial regions, in parts of Asia, and in the Southern Hemisphere) will see a young society dominated by teenagers and young adults. This phenomenon will be caused by higher death rates and larger birth rates than in the North. It will be compounded by poverty and the lack of access to education and advanced medical technology.

In postindustrial states, there will be a significant expansion of the metropolitan/suburban complex. With rapidly expanding telecommunications and information network technology, businesses will not have to be located in cities.[12] This migration is already occurring in the United States and will increase significantly in the future. The number of regional centers capable of providing such common necessities as transportation, pollution control, and water supply will increase. Microstates, similar to Singapore and Hong Kong, may also proliferate.

The labor force, primarily in the wealthy states, will seek and achieve higher levels of individual quality of life. The semi-skilled labor force will want increased leisure time with shortened workweeks and workdays. Its members will want to live in areas where leisure time can be enjoyed to the fullest and where they can avoid the effects of inner-city crime. Wealthy states will have an increased percentage of the permanently unemployed wards of the states.

Finally, nonstate associations will increasingly influence world culture. Religious extremists of all kinds will exert great influence on human affairs without regard for national borders. Transnational corporations, such as the automotive, fashion, and entertainment industries, will also influence the cultural lifestyle. Various environmental groups will aggressively seek to change government and business behavior and the lifestyle and activities of people.

While the geopolitical arena will be in great flux, the concept of the state will still dominate. New and evolving states will result as a consequence of wars of ethnic self-determination, migrations to avoid social discrimination, economic hardship, internal war, resource appropriation or depletion, or the impact of climate variability. The end result of this social and political flux will be more world players, more variables, and more nonlinearity in geopolitical interactions.

Geopolitics. The world will be multipolar, with states loosely organized in regional confederations. The European Community, the Asian Pacific Economic Community, the Organization of Petroleum Exporting Countries, the Organization of American States, and, now, the trading confederation resulting from the passage of the North American Free Trade Agreement are all current examples of this emerging phenomenon. The United States will remain a global power far into the twenty-first century because of its wealth, technological superiority, military power, and ability to build consensus among other states. Other regional centers of power including Germany—especially if the European Community becomes a strong entity—as well as Japan, China, and perhaps Brazil and Russia will arise.

Nonstate entities will continue to exert great influence. Transnational corporations, criminal and extremist elements, burgeoning private voluntary organizations, and nonstate-based political groups will overtly or covertly seek to play a major role in national and international policy decisions. Many believe national governments will become more inwardly focused, concentrating on the welfare needs of their populations and leaving more of the world community concerns to a stronger United Nations or regional associations.

Economics. The world's gross domestic product (GDP) will double by 2020, assuming an average annual growth rate of 3.2 percent for the planet as a whole. The United States will remain the world's largest national economy, but its percentage of the world's GDP could be less than the current level of about 22 percent.

The largest GDP growth is expected in the Asian-Pacific area. Trade agreements will become increasingly more important than state-to-state military alliances and treaties.

There will be a strong belief that economic security is more important than military security. Because of the likelihood that transnational corporations will be linking the world's economies, many will view international and national security as interdependent and almost inseparable.

Technology. High-speed, high-volume telecommunication technology—coupled with orders-of-magnitude increases in computer speed, storage, and capacity—will make possible the development of vast, interactive computer information data bases that are globally networked.[13] With this technology integration, the vast knowledge of the world could be brought to the individual sitting at his or her home computer. Adding virtual-reality technology, an individual at home could have the sense of being in another location, interacting visually with other individuals and doing things with them, without ever leaving the comfort of the computer chair. Microminiaturization of computer chips and nanotechnology, coupled with artificial intelligence, will revolutionize product development and greatly expand the use of robotics in daily life.

Information technology and supercomputing will facilitate understanding of the genetic architecture of life forms. By 2020, the world will be engulfed in the beginning of a genetic engineering revolution. This new technology will be used to improve our quality of life and medicine, as well as increase the food supply; however, it will also trigger many moral issues.

There is great promise that economical alternative sources of energy will be developed which will lessen the need for fossil fuels. New sources may come from cold fusion and the new hydrogen technology, as well as vastly improved chemical and solar batteries. Technological research and development could harness energy from the sun by the way of orbiting energy-converter satellites. The satellites could capture the full force of the sun's radiation, convert it to microwave energy, and transmit the energy via a directed beam to a power distribution point on earth, where it is converted to electricity. Several benefits, including a cleaner environment and a nearly unlimited electric fuel supply, could be realized from this type of technological development.

Technological change will continue to be exponential. With advanced tools; increased creative opportunities; and continuing growth in discovery, storage, and dissemination the rate of change may be more rapid than at any other time in human history.

Environment. The last forcing function shaping the world system is the environment. As the earth's population grows, the stress on the environment will grow. Past civilizations have undergone forced migrations because of their abuse of the earth, primarily from overcultivation and lack of land conservation. With the growth of the population being the highest in poor countries, there will be significant increases in environmental pollution in these areas. This will further decrease the quality of life of poor states.

Regional weather will see increasing variability due to such human-induced changes in the environment as extensive irrigation, overcultivation allowing more dust to enter the atmosphere, increasing carbon dioxide levels in the atmosphere, and increased cloudiness due to air pollution. Some regions may experience extreme climate changes, which could impact their water and the food-producing capabilities.

The depletion of natural resources will continue to be a concern. Most critical will be the availability of fresh, uncontaminated water. A severe drought lasting several years can throw a region into chaos and force the migration of large numbers of people. Wealthy regions will be able to overcome these situations, but poorer regions will have much more difficulty. Contamination of fresh water will continue to increase, especially in the poorer countries. Populations migrating to find food, water, or a more hospitable environment will, in turn, force other environments out of balance.

Future Sources of World Conflict

The future world will not be balanced. The cause of this imbalance will be a significant gap between the "haves" and "have-nots" or "have-lesses" of the world. Large portions of the world will become very high-tech, more materialistic, and somewhat selfish. Wealthy countries will seek increased levels of comfort for their people and will strive for the gain

of wealth through the control of knowledge. These countries will make attempts to help the poorer regions, but these attempts will often be ineffective. The populace of wealthy states will resist personal self-sacrifice. People will be reluctant to support national policies if they believe the policies will adversely affect their pocketbook and if they see no long-term personal benefits.

A crisis in values may also occur due to the rise in individualism caused by the immense access to information technology and the pursuit of happiness of the wealthy labor force. Such public concerns as education, transportation, law enforcement, and medical care may conflict with the individual's desire to pursue wealth.

In the United States the will and character of the American society will provide strong influence for US space control and exploitation. Americans will support a more vigorous space program only if they see economic benefits coming to them personally and/or if the space program protects the state and their way of life from a perceived threat.

Traditional sources of conflict, such as territorial ambition, regional rivalries, and ancient ethnic or religious hatreds will not go away (fig. 6). Other factors may become even more important in the twenty-first century. The increased prominence of economics in national security could also increase its role as a source of conflict. The belief that economic security

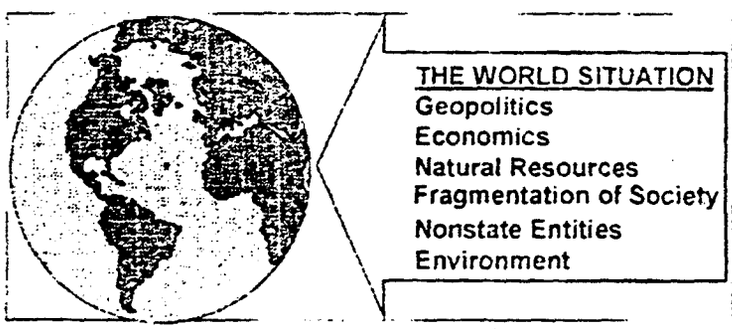

Figure 6. Issues Shaping the World Situation; Potential Sources of Future Conflict

underpins and is more important than military security will grow. Rivalry between economic blocs will spark conflicts, some of which may become wars. The gaps between the rich and poor will grow, as will the tension between the groups. Because of these shifts, rich countries are not likely to invest in space unless there is a benefit to economic as well as military security. Space investment for national security will, therefore, need to have commercial applications to be viable. Countries which cannot afford to invest in space for either commercial or national security purposes may be among the have-not countries of the twenty-first century.

Resource limits may lead to competition and perhaps conflict. Those who have-not or have-less may come into conflict with those who have. Resource management monitoring from space could help alleviate some of these problems. The fragmentation of societies and the differences between racial, ethnic, religious, political, or special-interest groups will cause conflicts within states and between states. New states will arise out of wars of ethnic self-determination. Today's family of 170 to 180 states will increase to perhaps as many as 250, with most new states forming along clan, tribal, or ethnic lines in the regions of Eastern Europe and Africa. This proliferation of states and groups on earth will present an additional monitoring problem for the United States. The US will retain more space systems to remain aware of and perhaps influence world events.

In the twenty-first century, states will not become irrelevant or obsolete. However, the number, influence, and power of nonstate actors will continue to increase. The number and power of criminal, ethnic, and religious groups will also increase. Extremist factions will continue to exist. Air, sea, and land piracy, smuggling, trafficking in outlawed goods, blackmail, theft of information, industrial espionage, technology sabotage, and other activities will bring states into conflict with nonstate groups. Armed force, violence, and terrorism used by nonstate groups will continue to pose a threat to states. Weapons of mass destruction and the means to deliver them will proliferate. The awareness provided by space forces can help with understanding the movement and activities of these hostile state and nonstate groups. Above and beyond the inherent advantages of monitoring the activities

of single states, global situational awareness can help us stay ahead of nonstate groups by identifying linkages between the separate terrorist or other cells scattered around the world.

Environmental noncompliance, including violation of nuclear and hazardous waste disposal agreements and the violation of water rights, will be sources of disputes. Sensitivity to environmental threats will make world powers willing to use coercive means up to and including force to bring environmental dangers under control. The sovereignty of states in the future will include their perceived right to clean air and water. Multispectral systems will be essential for global monitoring of the environment. States will use space systems to fix blame and liability on violators.

Future Interdependence between the Military and Civil/Commercial Sectors

There is an area of fusion or overlap between the range of civilian and military responses to the new world, specifically in the medium of space (fig. 7). States with affordable and as-required access to space will have commercial and military advantages over those who do not. The great powers will remain great in the next century only if they have assured access to space.

The world will see orders of magnitude improvements in many areas. Lightweight materials and improved propulsion technology will give the United States and other states affordable access to space. Artificial intelligence systems, supported by supercomputers, will use fused information derived from space systems to automatically generate threat forecasts, courses of action, and best responses for consideration by human decision makers. Onboard supercomputers, improved sensors, and satellite proliferation caused by reduced lift costs will make space systems less dependent on ground infrastructures for tracking, telemetry, and satellite control. Directed-energy weapons can permanently or temporarily disable satellite functions and will probably be the preferred antisatellite weapons technology for wealthy states.

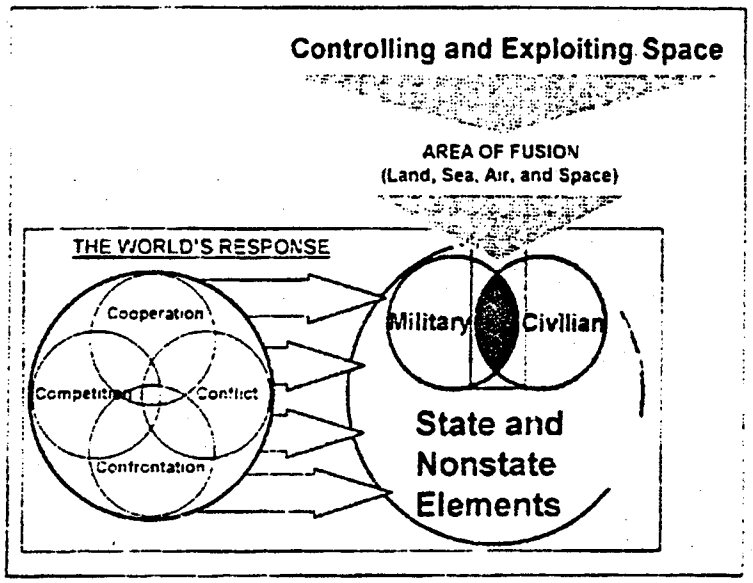

Figure 7. Controlling and Exploiting Space

As the United States proceeds into the next century, resource constraints may cause civil, commercial, and military space activities to converge with increasing military use of civil/commercial space applications. Distinctions between military and commercial space systems will continue to erode. An increased number of military systems will be military only because of the ways in which the military manipulates, fuses, and uses the data provided by commercial systems. The military will cooperate with and rely on the private sector to provide more or most of its space capability for computing, communications, navigation, weather, and earth resources sensing. Many scientific activities will also be useful for commercial and military purposes. Exploiting these synergies could help develop technologies and operational concepts for national security applications. Civil remote sensing for national security purposes will continue.

Resource limitations may provide opportunities for cooperation between the Department of Defense and nonmilitary space organizations. On the commercial side, these activities or industries will benefit from the same advances in compact supercomputers, affordable lift, improved sensors, and directed-energy data transmission, as will the military. If economic security is seen to underpin military security, the success of these activities or industries will be necessary to guarantee America's place as a world power in the next century.

Affordable, as-required spacelift could provide the United States as much surveillance; navigation; and command, control, and communications capabilities as it requires. It could also provide space systems that give the decision makers instantaneous awareness and virtual presence anywhere on the planet. Affordable lift could also give combatant forces small, commander-launched and controlled combat space systems for information warfare, electronic combat, precision weapon guidance, target identification and illumination, and up- and down-linking with unmanned aerial vehicles. Wealthy countries will consider their space infrastructure part of their sovereign territory and will develop robust antisatellite and advanced satellite defense technologies to protect it. Superiority in speed, position, and information will be the keys to dominance in combat environments. Much of this technology will be proliferated, however, and many states will have a deployed or breakout antisatellite capability.

Because of national dependence on space-derived information, space surveillance and control will become as important as airspace or sea-lane surveillance and control. An international body could assume more responsibility for space surveillance and satellite deconfliction operations. Coalitions of the great states may also operate space-based equivalents of the airborne warning and control or joint surveillance target attack radar systems to allow continuous observation of the earths surface to detect and deter hostile military activities.

There are other specific areas in which international cooperation in space could occur. With more and more states entering into the space arena, the need for deconfliction of orbits will increase. Orbital space debris is an

increasing hazard to our activities in space. Debris in orbit, some of which is too small to be tracked by Air Force Space Command, presents a potentially lethal threat to space operations and has made some desirable orbits unusable. States need to seek a way to cooperatively control and collect space debris. Also hundreds, perhaps thousands, of asteroids travel in orbits that intersect the earths orbit. Some have struck the earth in the past and left large craters. Others have come very close. Action should be taken to increase the world's capability to detect and define the orbit of the asteroids as well as to deflect or destroy those asteroids predicted to impact earth.

With the expected proliferation of nuclear weapons and delivery systems, there would be a need to deploy defensive systems capable of protecting important areas of operations by detecting theater, national, and international missile launches. States or nonstate elements could subscribe to the protection service. If economic interdependence is an expected characteristic of the future, cost-sharing partnerships should also be expected.

Conclusion

SPACECAST 2020 offers a rich glimpse into the future. While the true future is not predictable, the SPACECAST 2020 world implies clear imperatives and the alternative futures suggest important risks and opportunities. The future harkens and challenges us to shape it. Clearly considering the possibilities is the first step. Next, we must create objectives and strategies so robust that our course of action is appropriate no matter what the future holds. Such was the challenge presented to the SPACECAST 2020 participants.

Reacting to the future, creating ways to live and operate in the future, shaping the future—each is the task of the strategic decision maker and planner; each was the task of SPACECAST 2020 participants. Teams used the different proposed futures to enrich the concepts about future space activity they were beseeched to conjure. Teams were not bound to conform to the most likely SPACECAST view of

the world or any other future. Instead, they were charged with conceiving of ways to enhance US abilities to operate in, to, and from space. Clarifying how their concept contributed in each of the futures added detail and worth. Thus, each of the future space world scenarios served as a vehicle for testing the concepts and capabilities having emerged from the SPACECAST 2020 studies. By looking far ahead, SPACECAST participants have come to appreciate that we need not resign ourselves to being victims of the future. We can help shape the future we desire.

Notes

1. The process developed by the study group is described in The SPACECAST 2020 Process (Maxwell AFB, Ala.: Air University, 1994).

2. The group was led by Joseph A. Engelbrecht, Jr., an Air Force colonel with a PhD, who had previously been a strategic planner for Air Force headquarters. The groups concentrated efforts spanned two days. Charles W. Thomas and Peter J. McKenney of The Futures Group, an international consulting firm specializing in long-range planning, supported the second day's activity.

3. Harold S. Becker, "Scenarios: A Tool of Growing Importance to Policy Analysts in Government and Industry," *Technological Forecasting and Social Change*, no. 23 (1983): 95–120.

4. To illustrate that unexpected events can be routinely considered using the technique of alternate futures, it is noted that no one predicted the toppling of the Berlin Wall, the collapse of the Warsaw Pact, and the dissolution of the Soviet Union in the early 1980s. Yet in 1983, the Air Force's *Innovation Study* constructed four alternate futures as a basis for considering ways to increase an environment and culture fostering innovation. One of the scenarios considered a world in which the Soviet Union was no longer a significant player on the international scene. Report to the chief of staff: *Air Force Innovation–Shaping the Future, 1986.*

5. John H. Stewart II, "Methods for Developing Alternative Futures and Long-Range Planning," in Perry M. Smith, et al., *Creating Strategic Vision* (Washington, D.C.: National Defense University Press, 1987), 49–92. He critiques the use of scenarios or alternate futures as a methodology for long-range planning.

6. *Technomic* is a word coined by Col Joseph A. Engelbrecht, Jr., and his team. His definition is "of or relating to progress in the development of the application of scientific principle (technology), and in the development of wealth (economics), and in the interrelationship

between advances in science and the spread and increase of economic wealth. Technomic vitality. Technomic proliferation."

7. In developing the alternate futures, the SPACECAST 2020 team rated the nature and amount of space activity and military involvement in space by comparing each of the alternative futures. The team rated the activity on a scale of 1 to 10 in several areas to suggest the differences. In this manner, for example, counterforce activity might be rated low (about 2) in one world and moderate (4–6) in another world. The purpose of the ratings was to provide granularity to the environmental pressures of the alternate futures on the development or maintenance of these military space functions. *Counterforce operations* are those space or transatmospheric activities aimed at opposing or defending against threatening force anywhere on the planet or in the region of space. Although counterforce activities are defensive in intent, they do not preclude defense by offensive action. Counterforce activities include the use of information and weather as weapons. They also include defense against nonhuman threats to the vitality and security of the United States and the people on the planet. Air University, "Glossary," SPACECAST 2020, vol. I (Maxwell Air Force Base, Ala., June 1994), V-8.

8. *Logistical activities* are defined as "broadly encompassing all the activities aimed at providing and sustaining access to space. These include building and maintaining a space operations infrastructure and training the human resources that sustain space logistics, monitoring and reporting from space, and counterforce operations." In the SPACECAST 2020 report logistics activities include space research and development, space system design and procurement, space launch operations, on-orbit maintenance and resupply, tracking, telemetry, and spacecraft systems commanding (TT&C), de-orbit operations, and education and training for military space operations. "Glossary," SPACECAST 2020, vol. I, V-6 through V-7.

9. *Monitoring and reporting activities* are defined as "those directed towards observation and orientation to reduce uncertainties, and to provide communications for the purpose of exercising command of military forces. Although omni-spectral surveillance of the planet and of space are important elements of this area of activity, others include using space and the vertical dimension for the command of forces operating in all media. communications, navigation, and for the information collection and fusion that, assisted by computational power, results in intelligence. In the area of monitoring and reporting there are many commonalities between national security needs and systems and the systems serving the needs of business and commerce." "Glossary," SPACECAST 2020, vol. I, V-8 through V-9.

10. Carl Builder, the well-known RAND analyst who spoke to the SPACECAST 2020 study group in Jones Auditorium, Air War College,

emphasized the need to take stock in what is not changing and to look for long-term trends in changes which appear confusing. Maxwell AFB, Ala.: Air University, September 1993.

11. The elaborate task of synthesizing the SPACECAST 2020 consensus world view was led by Col Richard Szafranski, the study's research director. Lt Col Tamzy House and Maj William Bruner were the first to articulate the SPACECAST 2020 assumptions and suggested the model to illustrate them.

12. Alvin Toffler, who also spoke to the SPACECAST 2020 group, predicted these developments in several of his earlier works such as *Future Shock* and *Third Wave* with Heidi Toffler (Boston: Little, Brown, and Company, 1993).

13. This section merely introduces the technologically obvious. The study participants were aware of many potential technological opportunities early in the study as they sketched their vision of the future. Key points are summarized here. Details of the technologies became more clear as the study progressed and are discussed in the study report. The technologies most relevant to US activity in space were evaluated using operational analysis techniques. For a description of the technological analysis process see *Operational Analysis* (Maxwell AFB, Ala.: Air University, 1994).

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